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Experimental Study On Partial Replacement Of Cement With GGBS.

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Abstract : - Cement in concrete has several disadvantages when used without any replacement to it in concrete such as high carbon footprint, high cost of construction, and low tensile strength. To address these disadvantages alternative materials such as fly ash, GGBS, and silica fume can be used, designing concrete mixtures with lower cement content can reduce the carbon footprint, cost, and potential cracking, resulting in more sustainable, cost effective, and durable concrete structures. In our project we are going to use GGBS as a replacement material to cement in varying percentage. GGBS stands for Ground Granulated Blast Furnace Slag. It is a byproduct of the iron and steel industry, produced during the process of iron production in blast furnaces. GGBS has cementitious properties and can partially replace cement in concrete mixtures. It improves the durability, workability, and long-term strength of concrete. GGBS also has a lower carbon footprint than traditional cement, making it an environmentally friendly alternative. It is commonly used in large-scale construction projects such as bridges, highways, and high-rise buildings. This experimental investigation is being conducted to compare the compressive strength of concrete mix of M30 grade with partial replacement of cement with varying percentage of GGBS of 10%,20% and 30% to the dry weight of cement in the mix and find out the optimum percentage at which the concrete mix has highest strength. We are going to test compressive strength of 36 cubes of concrete mix consisting of 9 cubes of nominal M30 mix and 9 cubes of each mix containing 10%,20% and 30% GGBS replaced mix at 7th,14th and 28th day from the day of cube casted.

IndexTerms **- GGBS, Compressive strength, Cement replacement, M30 grade concrete.**

I. INTRODUCTION

Partial replacement of cement with Ground Granulated Blast Furnace Slag (GGBS) is a technique that has gained popularity in the construction industry due to its numerous benefits. GGBS is a by-product of the iron and steel industry, produced by quenching molten slag from a blast furnace with water or steam, which results in a granular material. It has cementitious properties and can partially replace Portland cement in concrete mixes.

The use of GGBS in concrete has several advantages. Firstly, it significantly reduces the amount of Portland cement needed in the mix, thus reducing the carbon footprint of concrete production. This is because the production of Portland cement requires high temperatures and releases significant amounts of carbon dioxide into the atmosphere. By replacing some of the cement with GGBS, the amount of Portland cement used in the mix is reduced, and hence the carbon footprint is also reduced.

Secondly, GGBS improves the durability of concrete. This is because it reduces the permeability of the concrete, making it more resistant to water penetration and chemical attack. The use of GGBS in concrete can also improve its resistance to chloride and sulfate attack, which can cause concrete to deteriorate over time.

Thirdly, GGBS can improve the workability of concrete. This is because it has a smaller particle size than Portland cement, which makes it easier to mix with water. It also produces a smoother and more cohesive concrete mix, which makes it easier to place and finish.

Fourthly, GGBS can improve the long-term strength of concrete. This is because it reacts with calcium hydroxide, a by-product of the hydration of Portland cement, to form additional cementitious compounds. This results in increased strength over time, making the concrete more durable and long-lasting.

II. PROBLEM STATEMENT

We know that cement contributes significantly in the greenhouse gas emission as well as in the cost of construction, that's why we use various replacement materials to cement in concrete mix. One of those material is GGBS. It has various advantages when used as a replacement to cement in concrete mix but when used in specific percentage only. there is still a lack of understanding of the optimum amount of GGBS that can be used in concrete mixes to achieve these benefits while maintaining the required properties of the concrete. The problem statement for this research paper will focus on identifying the optimum amount of GGBS that can be used in concrete mixes while maintaining the required properties of the concrete.

III. AIM

To study the change in compressive strength of concrete by partial replacement of cement with varying percentage of GGBS.

IV. OBJECTIVE

1. to find out the compressive strength of concrete by partial replacement of cement with GGBS
2. to find out the optimum percentage of GGBS for the best results of compressive strength amongst the opted percentages in the project.
3. To reduce the environmental problem.

2. LITERATURE REVIEW

2.1 "STRENGTH AND DURABILITY STUDIES ON CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY GGBS" BY MOHANKUMAR R, R. SRINIVAS RAJU,DR. V RAMESH

For the study they had used M40 grade of concrete. Cement is replaced in 20%, 35%, and 50% to the original dry weight with GGBS. They carried out various tests on M40 concrete viz. compressive strength, split tensile strength, flexural strength on the 7th,14th and 28th day from the day of cube casted. The cured the each cube of every combination under normal curing, base curing and acid curing. From the results we can see that for compressive strength, 20% of cement replacement with GGBS gives best results.

2.2 "TO STUDY THE PARTIAL REPLACEMENT OF CEMENT BY GGBS & RHA AND NATURAL SAND BY QUARRY SAND IN CONCRETE" BY SONALI K. GADPALLIWAR , R. S. DEOTALE , ABHIJEET R. NARDE

this study involves three phases. In the first phase natural sand is replaced with quarry sand, in the second phase cement is replaced with GGBS and in the third phase both natural sand and cement are replaced with quarry sand and combination of rice husk and GGBS respectively under varying percentage to find out the optimum percentage opted to get best test results. In this research they casted cubes for compressive strength test, casted cylinder for split tensile strength test, casted beams for flexure strength test and permeable voids test. The teasts where conducted on 7th, 28th and 56th day from the day of specimens casted for M40 grade of concrete. They found that the addition of GGBS in concrete increases its workability but decreases strength.

2.3 "STUDIES ON OPTIMUM USAGE OF GGBS IN CONCRETE " BY M.RAJARAM ,A.RAVICHANDRAN , A.MUTHADHI

this research paper investigates the effect of ground granulated blast furnace slag (GGBS) on the properties of concrete of m25 grade. The study was conducted by preparing concrete mixes with 0%, 5%, 20%,35% and 50% GGBS replacement of cement. The compressive strength, split tensile strength, and flexural strength were evaluated at 7, 14, and 28 days. The study found that the test results for each test decreases with an increase in the percentage of GGBS replacement. However, the study also revealed that there is an optimum percentage of GGBS replacement for each grade of concrete, beyond which the strength properties decline significantly. Based on the results, the optimum replacement percentage of GGBS for M25 grade concrete was found to be 20% for 28-day compressive strength. The study concludes that the use of GGBS in concrete can improve its durability and reduce the amount of cement used, but its replacement percentage should be optimized to achieve the desired strength properties.

2.4 "STUDY ON COMPRESSIVE STRENGTH OF CONCRETE ON PARTIAL REPLACEMENT OF CEMENT WITH GROUND GRANULATED BLAST FURNACE SLAG (GGBS)" BY RATHOD RAVINDER , K. SAGARIKA , K. DEEPTHI , P. ALEKYA REDDY , R. SPANDANA, S. SRUTHI.

The research paper titled "Study on Compressive Strength of Concrete on Partial Replacement of Cement with Ground Granulated Blast Furnace Slag (GGBS)" examines the effect of GGBS on the compressive strength of concrete. The study was conducted by preparing concrete mix by GGBS replacement of cement to 50%. The compressive strength of the concrete was evaluated at 7, 14, and 28 days. The study found that the compressive strength of concrete is less on the 7th day as compared to conventional concrete but it is found that the compressive strength is more on the 14th and 28th as compared to conventional concrete mix of M30 grade. The study concludes that the use of GGBS as a partial replacement for cement can reduce the carbon footprint of concrete and also improve its long-term durability.

2.5 "EFFECT OF ADDITION OF FLYASH AND GGBS ON CEMENT CONCRETE IN FRESH AND HARDENED STATE" BY B K VARUN , HARISH B. A.

This research paper investigates the effect of fly ash and GGBS on the properties of cement concrete in both fresh and hardened states. The study was conducted by preparing concrete mixes with varying percentages of fly ash and GGBS, ranging from 0% to 60% replacement of cement. The study was carried out on the M30 grade of concrete. the tests were conducted on 28th day, 56th day and 90th day from the day of specimens casted. The properties of the concrete were evaluated in terms of compressive strength, workability, and durability. The study found that the addition of fly ash and GGBS improved the workability of the concrete mix and also resulted in an increase in compressive strength. However, the addition of fly ash and GGBS beyond a certain percentage resulted in a decrease in compressive strength. The study also found that Incorporation of Fly ash and GGBS as a partial replacement of cement in concrete gives good results in both fresh and hardened state.

2.6 "PARTIAL REPLACEMENT OF CEMENT WITH GGBS IN CONCRETE" BY CHALAMCHARLA VENU GOPAL, SURESH .A, V. GOKUL NATH

The research paper explores the possibility of using Ground Granulated Blast Furnace Slag (GGBS) as a partial replacement for cement in concrete. The study aims to evaluate the compressive strength of concrete specimens containing varying percentages of GGBS.The authors conducted laboratory experiments by preparing concrete mixes with different percentages of GGBS, ranging from 0% to 40%. They measured the compressive strength at the 7th and 28th day from the day of specimen was cast. The test were conducted on the concrete mix of M25 grade. The paper also explains the material used and the methodology followed for performing the entire test. The results show that as the percentage of GGBS in the mix increased, the compressive strength of the concrete decreased slightly. The compressive strength of concrete mix with 40 percentage replacement were found to be less as compared to compressive strength of concrete with 20 percentage of ggbs replacement The study concludes that using GGBS as a partial replacement for cement can improve the compressive strength and durability of concrete, as well as reduce the carbon footprint of concrete production.

2.7 STRENGTH AND DURABILITY STUDIES ON GGBS CONCRETE SANTOSH KUMAR KARRI , G.V.RAMA RAO , P.MARKANDEYA RAJU

The research paper presents a study on the strength and durability of concrete containing ground granulated blast furnace slag (GGBS) as a partial replacement for cement. The study aims to evaluate the compressive strength, flexural strength, split tensile strength, and durability of concrete specimens containing varying percentages of GGBS. The authors conducted laboratory experiments by preparing concrete mixes with 30%, 40%, and 50% GGBS replacement. They measured the compressive strength, split tensile strength and flexural strength by casting cubes, cylinders and prism. the test were conducted on the concrete mix of M20 and M40 grade. the test results were taken on the 28th day and 90th day from the date of specimens casted . From the test results we can conclude that 30 percentage GGBS gives best results for compressive strength of both M20 and M40 grade of concrete. Furthermore, the study also investigated the effect of curing on the strength and durability of GGBS concrete and found that the curing period significantly influenced the properties of concrete. The study recommends that a longer curing period should be used for concrete containing GGBS to achieve higher strength and durability.

2.8 "GGBS AND FLY ASH EFFECTS ON COMPRESSIVE STRENGTH BY PARTIAL REPLACEMENT OF CEMENT CONCRETE" BY AZMAT ALI PHUL A., MUHAMMAD JAFFAR MEMON A. , SYED NAVEED RAZA SHAH A. , ABDUL RAZZAQUE SANDHU A.

The research paper investigates the effects of using Ground Granulated Blast Furnace Slag (GGBS) and fly ash as partial replacements for cement on the compressive strength of concrete. The study aims to evaluate the optimum percentage of GGBS and fly ash that can be used to achieve the highest compressive strength of concrete. The authors conducted laboratory experiments by preparing concrete mixes with different percentages of GGBS and fly ash, ranging from 0% to 30% by weight of cement. They then tested the compressive strength of the resulting concrete specimens at 3rd, 7th, 14th and 28th day from the date of the specimens were casted. the tests were taken on the concrete mix of M25 grade. The concrete mix were tested with the slump, compaction factor, Vee-bee and compressive strength. The results obtained from all these tests increases as the curing time increases.The results show that the addition of GGBS and fly ash to concrete as partial replacements for cement improved the compressive strength of the concrete, with the optimum percentage of GGBS and fly ash found to be 20% and 10%, respectively.

2.9 GGBS AS PARTIAL REPLACEMENT OF OPC IN CEMENT CONCRETE – AN EXPERIMENTAL STUDY BY YOGENDRA O. PATIL, PROF.P.N.PATIL, DR. ARUN KUMAR DWIVEDI

This paper presents a study on the compressive strength as well as flexural strength of concrete prepared by replacing cement with ground granulated blast furnace slag in different proportions ranging from 0% to 40%. The author conducted the test on the 7th, 28th, and 90th day from the date of specimen were casted. The study shows that the compressive strength of concrete is inversely proportional to the percentage of cement replacement. As the percentage of GGBS increases in the mix the strength of the concrete mix were decreasing. From the results we can conclude that the 10% replacement of cement with GGBS gives good results but from the results we can also say that the concrete mix without any replacement gives best result. we can also conclude that the results for compressive strength and flexural strength were increasing as the curing time is increases.

3. RESEARCH METHODOLOGY

4. OBSERVATIONS FROM LITERATURE

1. Ground Granulated Blast Furnace Slag (GGBS) is compatible to replace with normal OPC cement.

2. GGBS increases the workability of cement for sure.

3. Use of GGBS has an impact on the economy of the project.

4. compressive strength increases with increase in curing time.

5. M30 concrete has not been tested for compressive strength with 10%,20% and 30% Cement replacement with GGBS.

5. TEST RESULTS

7 DAYS COMPRESSIVE STRENGTH TEST RESULT

Nominal mixture

Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	28.44	
Cube 2	27.53	27.96N/mm^2
Cube 3	27.91	

10%GGBS Mixture

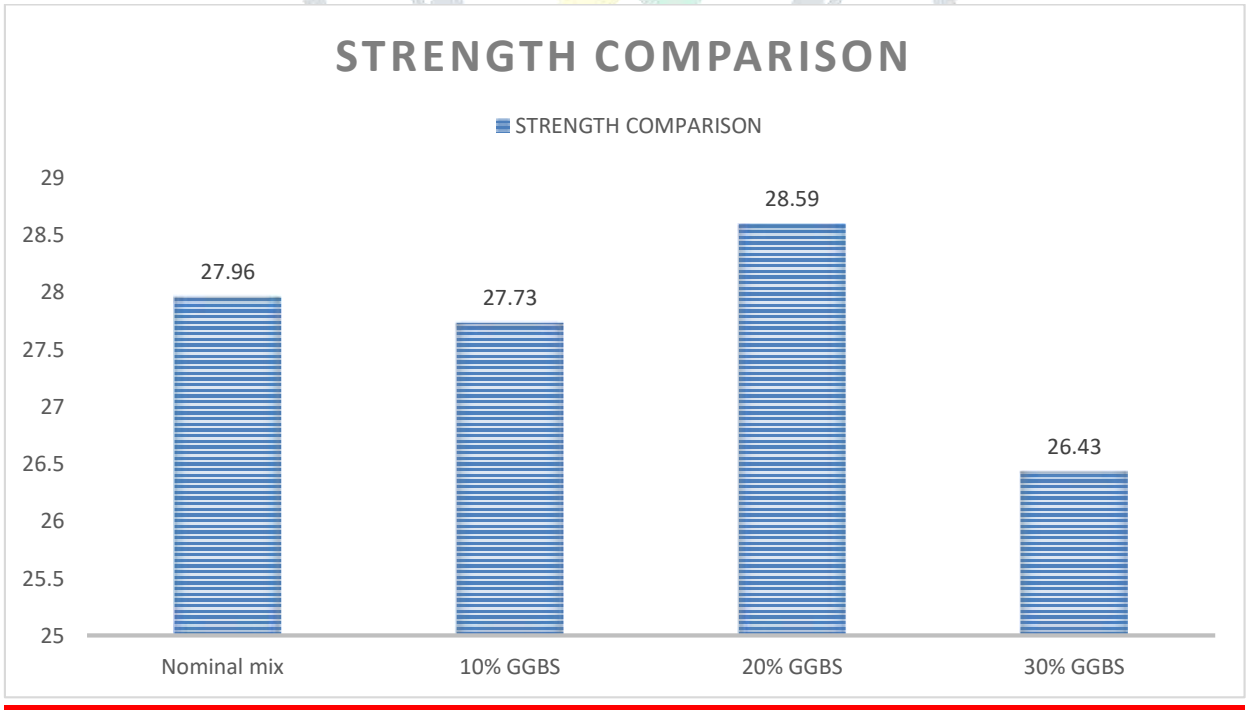
Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	27.50	
Cube 2	27.96	27.73N/mm^2
Cube 3	27.73	

20%GGBS Mixture

Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	27.90	
Cube 2	28.40	28.59N/mm^2
Cube 3	29.47	

30%GGBS Mixture

Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	25.93	
Cube 2	26.60	26.43N/mm^2
Cube 3	26.76	



14 DAYS COMPRESSIVE STRENGTH TEST RESULT

NOMINAL MIXTURE

Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	34.12	
Cube 2	32.6	33.14N/mm^2
Cube 3	32.7	

10%GGBS MIXTURE

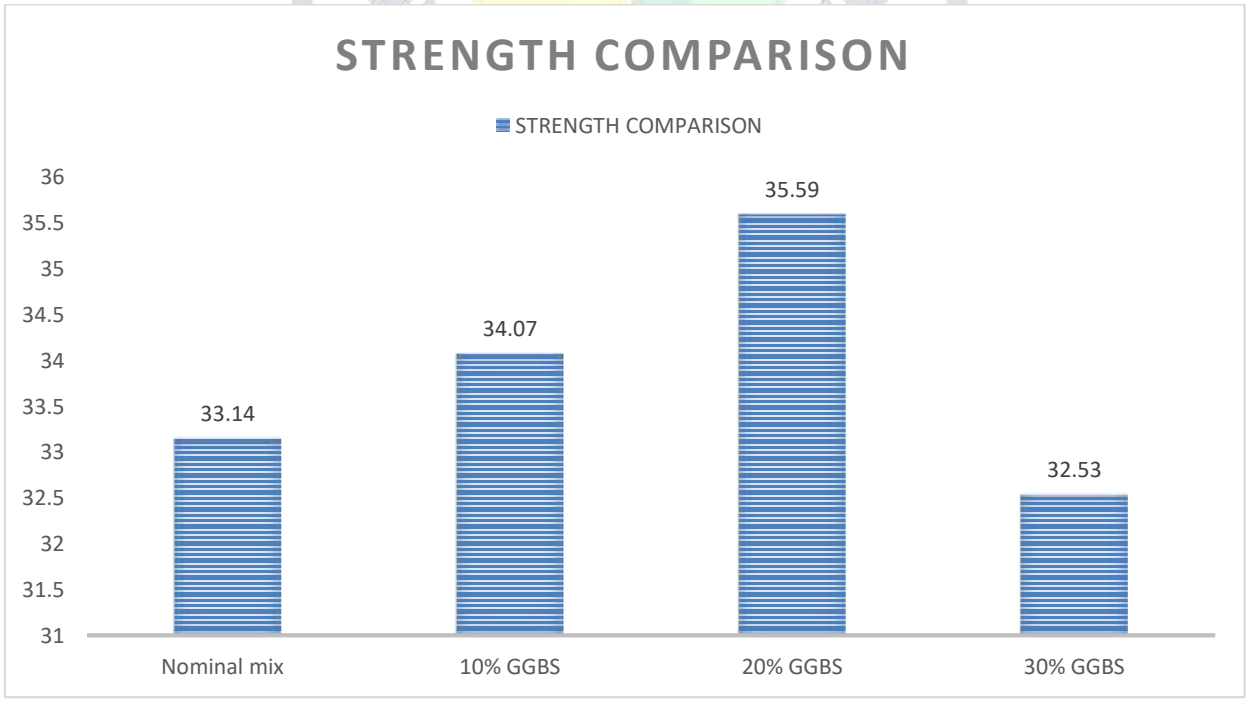
Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	34.53	
Cube 2	33.60	34.07N/mm^2
Cube 3	34.08	

20%GGBS MIXTURE

Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	35.43	
Cube 2	35.57	35.59N/mm^2
Cube 3	35.77	

30%GGBS MIXTURE

Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	33.13	
Cube 2	32.60	32.53N/mm^2
Cube 3	31.86	



28 DAYS COMPRESSIVE STRENGTH TEST RESULT

NOMINAL MIXTURE

Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	37.43	
Cube 2	37.77	37.61N/mm^2
Cube 3	37.63	

10%GGBS MIXTURE

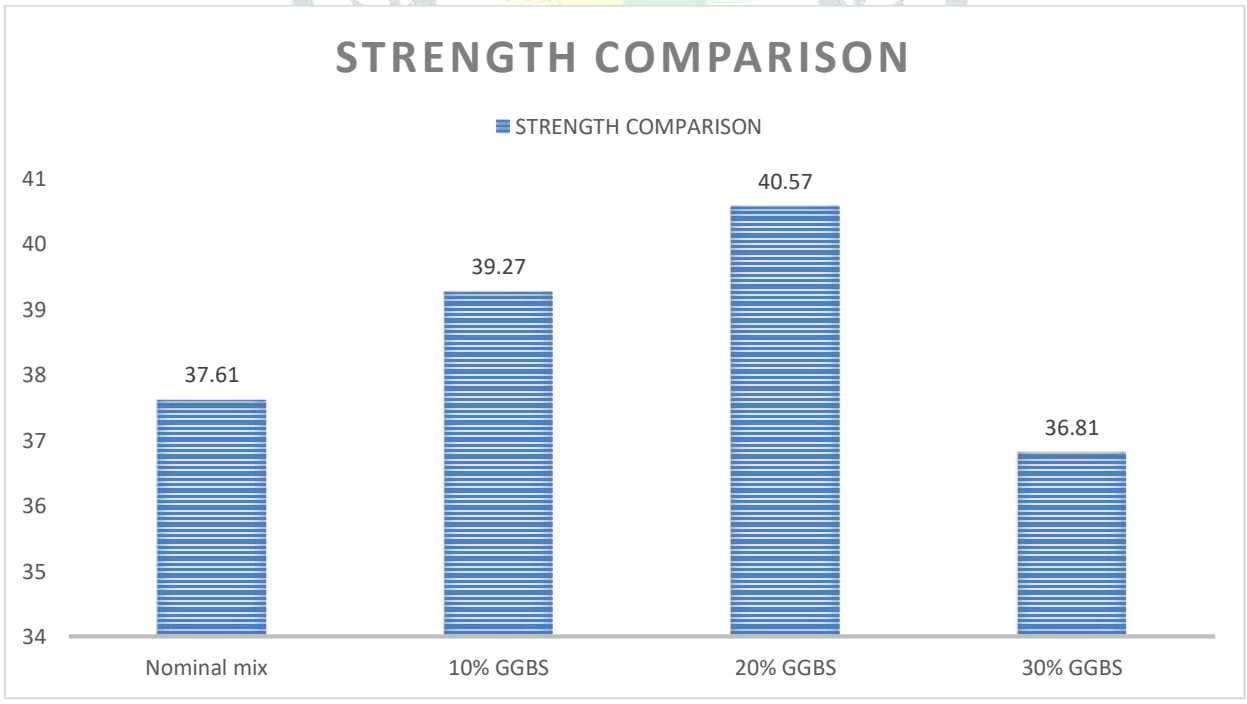
Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	38.75	
Cube 2	39.16	39.27N/mm^2
Cube 3	39.90	

20%GGBS MIXTURE

Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	40.93	
Cube 2	40.61	40.57N/mm^2
Cube 3	40.17	

30%GGBS MIXTURE

Cube numbers	Compressive strength(N/mm^2)	Average strength of three cubes
Cube 1	36.61	
Cube 2	36.90	36.81N/mm^2
Cube 3	36.92	



6. CONCLUSIONS

1. 20% cement replacement with GGBS is the optimum percentage for which we get the highest compressive strength.
2. Compressive strength gets reduced as compared to nominal mix when GGBS replacement is above 20%.
3. Compressive strength increases as the curing time increases.
4. Economy can be achieved by using GGBS as a replacement to cement.

7. ACKNOWLEDGMENT

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8. REFERENCES

[1] MohanKumar, R., R. Srinivas Raju, and V. Ramesh. "Strength and Durability Studies on Concrete with Partial Replacement of cement by GGBS." *Impact Factor* 2 (2017): 23.

[2] Gadpalliwar, Sonali K., R. S. Deotale, and Abhijeet R. Narde. "To study the partial replacement of cement by GGBS & RHA and natural sand by quarry sand in concrete." *IOSR Journal of mechanical and civil engineering* 11.2 (2014): 69-77.

[3] Rajaram, M., A. Ravichandran, and A. Muthadhi. "Studies on optimum usage of GGBS in concrete." *J. Innov. Science Res. Technol* 2 (2017): 773-778.

[4] Ravinder, Rathod, et al. "Study on Compressive Strength of Concrete on Partial Replacement of Cement with Ground Granulated Blast Furnace Slag (GGBS)." *National Conference on Water and Environment Society*. 2018.

[5] Varun, B. K., and B. A. Harish. "Effect of addition of fly ash and GGBS on cement concrete in fresh and hardened state." *Int J Adv Eng Res Dev* 5.2 (2018).

[6] Gopal, ChalamcharlaVenu, and A. Suresh. "Partial Replacement of Cement with GGBS in Concrete." *IJARIIT, ISSN* (2017).

[7] Karri, Santosh Kumar, GV Rama Rao, and P. Markandeya Raju. "Strength and durability studies on GGBS concrete." *SSRG International Journal of Civil Engineering (SSRG-IJCE)* 2.10 (2015): 34-41.

[8] Phul, Azmat Ali, et al. "GGBS and fly ash effects on compressive strength by partial replacement of cement concrete." *Civil Engineering Journal* 5.4 (2019): 913-921.

[9] Patil, Yogendra O., P. N. Patil, and Arun Kumar Dwivedi. "GGBS as partial replacement of OPC in cement concrete–An experimental study." *International Journal of Scientific Research* 2.11 (2013): 189-191.